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Chief, Medical Research Division.

1st Lieut. H. A. Kuhn, C.W.S.
Chief, Dept. of Toxicology.

REPORT NO. E.A.M.R.D. 15, Copy 2.
PROJECT NO. A3.1-3.

SUBJECT: Minimum Lethal Concentrations, Symptomatology, and Pathology of Phosgene.

BY: G.C.Armstrong,
M.G.Witherspoon.

DATE: September 15, 1923.

[redacted]

MINIMUM LETHAL CONCENTRATIONS, SYMPTOMATOLOGY, AND PATHOLOGY OF PHOSGENE.

by

G.C.Armstrong
and
M.G.Witherspoon.

September 15, 1923.

[redacted]

ABSTRACT.

A. TOXICITY.

The work herein reported supersedes that of Report E.A.M.R.D. #5 when conflicts in data are found. The present results have been obtained in a new type of chamber where the length of exposure can be entirely controlled, and changes in concentration made a matter of a second.

The minimum lethal concentration of phosgene for dogs by inhalation in a gas-air mixture is reported for the following periods of exposure:

Length of Exposure in Seconds	Minimum Lethal Conc. in Milligrams per L.	CT Constant*	Number of Dogs Used
30	16.19	8.1	28
60	8.41	8.14	28
180 (3 min.)	1.51	4.53	29
300 (5 min.)	0.85	4.25	29
450 (7½ min.)	0.62	4.65	23

*CT = Concentration multiplied by time. C is expressed in milligrams per liter and T in minutes.

B. SYMPTOMATOLOGY AND PATHOLOGY.

Exposure to phosgene causes irritation of the exposed mucous surfaces leading to lachrymation, salivation, and increased nasal secretion. Following exposure more profound effects such as profuse nasal secretion, conjunctivitis, and respiratory difficulties are noted. Death usually occurs within 24 hours and the common gross pathological findings are edema, hemorrhage, congestion, atelectasis, and emphysema of the lungs, hydrothorax, dilatation of

the right ventricle of the heart, congestion of the kidneys, liver, and spleen. Microscopic examination of the tissues confirms these findings. When death occurs after 24 hours bronchc pneumonia or bronchitis is frequently found.

TABLE OF CONTENTS.

MINIMUM LETHAL CONCENTRATIONS, SYMPTOMATOLOGY, AND PATHOLOGY OF PHOSGENE.

I. INTRODUCTION.

The object of this work is to determine the minimal lethal concentration of phosgene for dogs exposed to various concentrations of the gas-air mixture, and to study the symptomatology and pathology resulting from such exposures. The minimal lethal concentration for the following periods of exposure was determined: 30 seconds, 60 seconds, 180 seconds (3 minutes), 300 seconds (5 minutes), and 450 seconds (7½ minutes).

The minimal lethal concentration is defined as the lowest concentration which will produce a majority of deaths within 48 hours after exposure.

This work was started by W. O. Scott, continued by R. E. Morse, and completed by G. C. Armstrong.

II. HISTORICAL.

Previous work upon the toxicity of phosgene for dogs (Report M.A.M.R.D. #6) reported a lethal point for all corresponding periods of exposure consistently higher than that reported in the present work. In the previous work, however, but little attempt was made to simulate field conditions. By the former method the dog was placed in a chamber prior to the release of the gas, and the gas-air mixture made with the subject in the chamber. Thus at the beginning of the exposure the concentration increased from zero to maximum, and on completion decreased from maximum to zero before the dog was removed from the chamber. This resulted in the introduction of a variable factor of error at both the beginning and end of the run. In the former work only exposures of 7½ minutes and above are reported since at and above that period the two factors of error were accepted as almost balancing each other in effect. The present work was carried out in a specially constructed chamber in

which the dogs might be placed prior to release of gas, but without being exposed during the period in which the concentration was being regulated. By the manipulation of very rapid valves the onset of a gas-air mixture and its suppression were controlled so that the interval between release of gas and its reception by the subject was practically nil. Likewise, the period between cessation of gas and the returning sweep of fresh air was negligible. Where there is a conflict in data with the former report the present data may be accepted as being the more accurate.

Winternitz in "Pathology of War Gas Poisoning" studied the pathological effects of phosgene on dogs exposed in an ordinary closed chamber for periods of 30 minutes to concentrations of approximately 0.2 to 5.0 mg/l. The findings reported in the following pages agree in general with this work. Report E.A.C.D. 101 gives a brief account of the gross pathology of dogs exposed in a glass chamber for 7½ minutes to concentrations between 0.98 and 2.11 mg/l.

III. EXPERIMENTAL.

A. Materials

The phosgene used was furnished by the Chemical Division of the Chemical Warfare Service at Edgewood Arsenal. Its analysis by chlorine content showed a purity of 98.6%.

B. Description of Apparatus:

THE TOXIC GAS CHAMBER. (Drawing Number One.)

Fresh air is drawn into the system at A and passes through the coils of the steam heater at B. The inflowing breeze is then divided and passes on through pipes C and C'. The flow through these pipes is made equal by regulating the gate valves at D and D'. C is called the "fresh air line" and C' the "gas line." The toxic gas is admitted to the C' line from a cylinder placed at F and having a lead line piercing the gas line at F'. The flow of gas from the cylinder is measured by the use of flowmeters. At G in the gas line is a pet-cock through which samples are aspirated for analysis. Throughout the gas line are a series of baffles the object of which is to thoroughly mix the gas-air mixture.

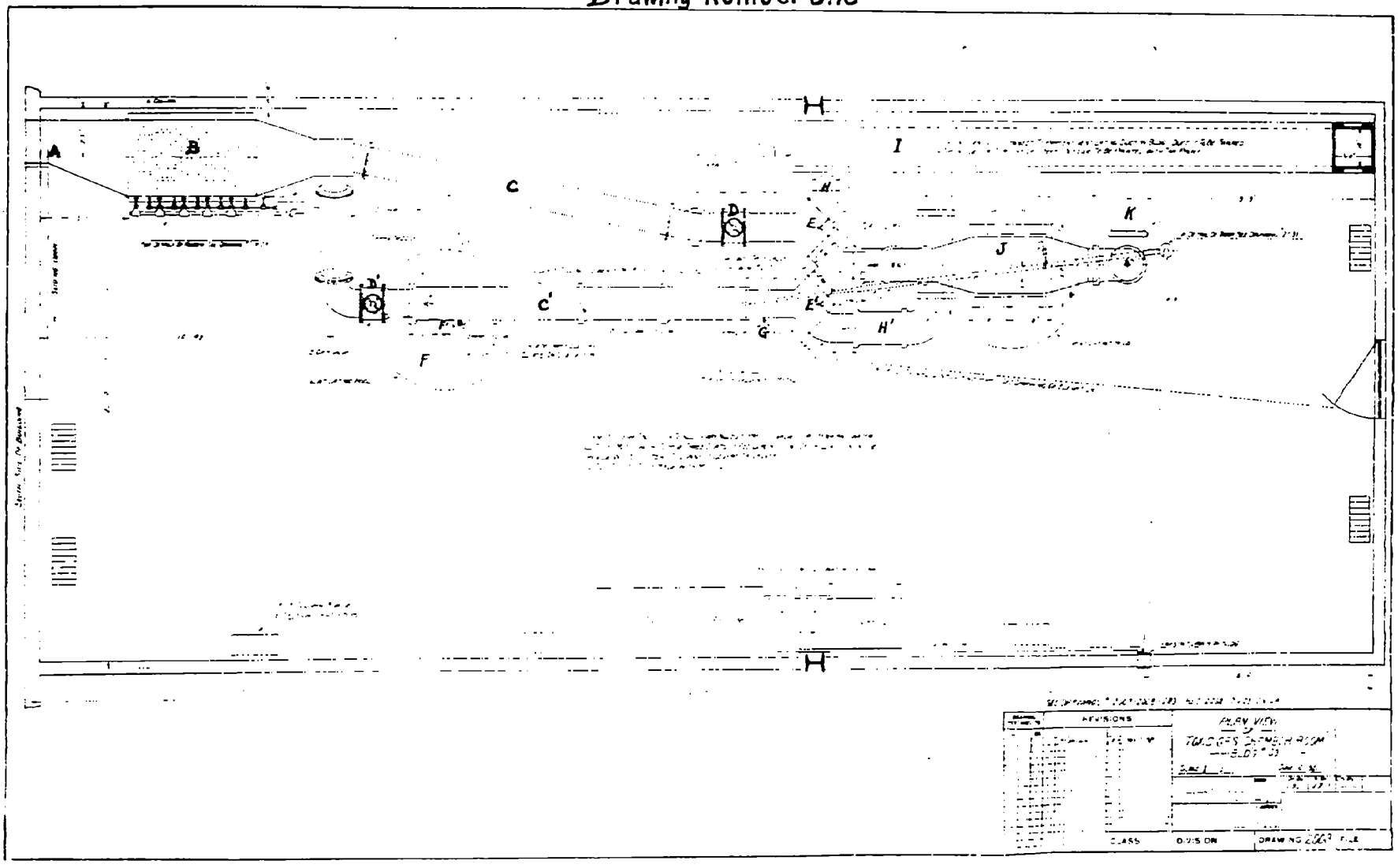
Both the fresh-air line C and the gas line C' now bifurcate-one branch of each H and H' leading to the waste duct I and the remaining branches joining and entering the chamber J through a common duct. Butterfly valves at each bifurcation H and H' are operated by the same lever. (For detail construction of these valves see Drawing Number Three.) Their effect is to allow but one line to discharge through the chamber J, and to divert the other into the waste line. Thus, if H is set to direct the fresh-air line flow into the chamber, H' is automatically closed against the gas line and it must pass into the waste line lead to H'. Vice versa, if H' is directing gas through the chamber, then valve H diverts the fresh-air line through its waste lead H into the waste line I. The value of the apparatus is due to the valves H and H'. Their manipulation is but the matter of a second so that a flow of gas may be instantly changed to fresh air, or vice versa. At the inlet and outlet of the chamber a system of screens insures an even distribution of flow within the cage. Manometric tests determined the position of these screens.

SCRUBBING TOWER FOR WASTE GAS DISPOSAL. (Drawing Number Two.)

The waste line carrying the gas-air mixture is led to the base of a scrubbing tower at L. Here it is drawn up through the tower where the toxic gas is absorbed. The devitiated air leaves the top of the tower at M, passes down through pipe N, into the revolving fan O, through duct P, and is finally released through the chimney Q. The electrically driven fan (5 H.P. motor) has been the power which drew the fresh-air into the system at A and kept it in movement throughout its course.

The scrubbing tower is of the common chemical type which is filled with hollow tile. From tank A aqueous sodium hydroxide is pumped to the top of the tower through pipe O, and by gravity it cascades down through the tile within the tower to the collecting pipe at A where the pump (2 H.P. motor) sends it on another cycle. An 8% solution of caustic is sufficient to neutralize a gas-air mixture containing 15 milligrams of phosgene per liter of air at the rate of three miles per hour.

Drawing Number One



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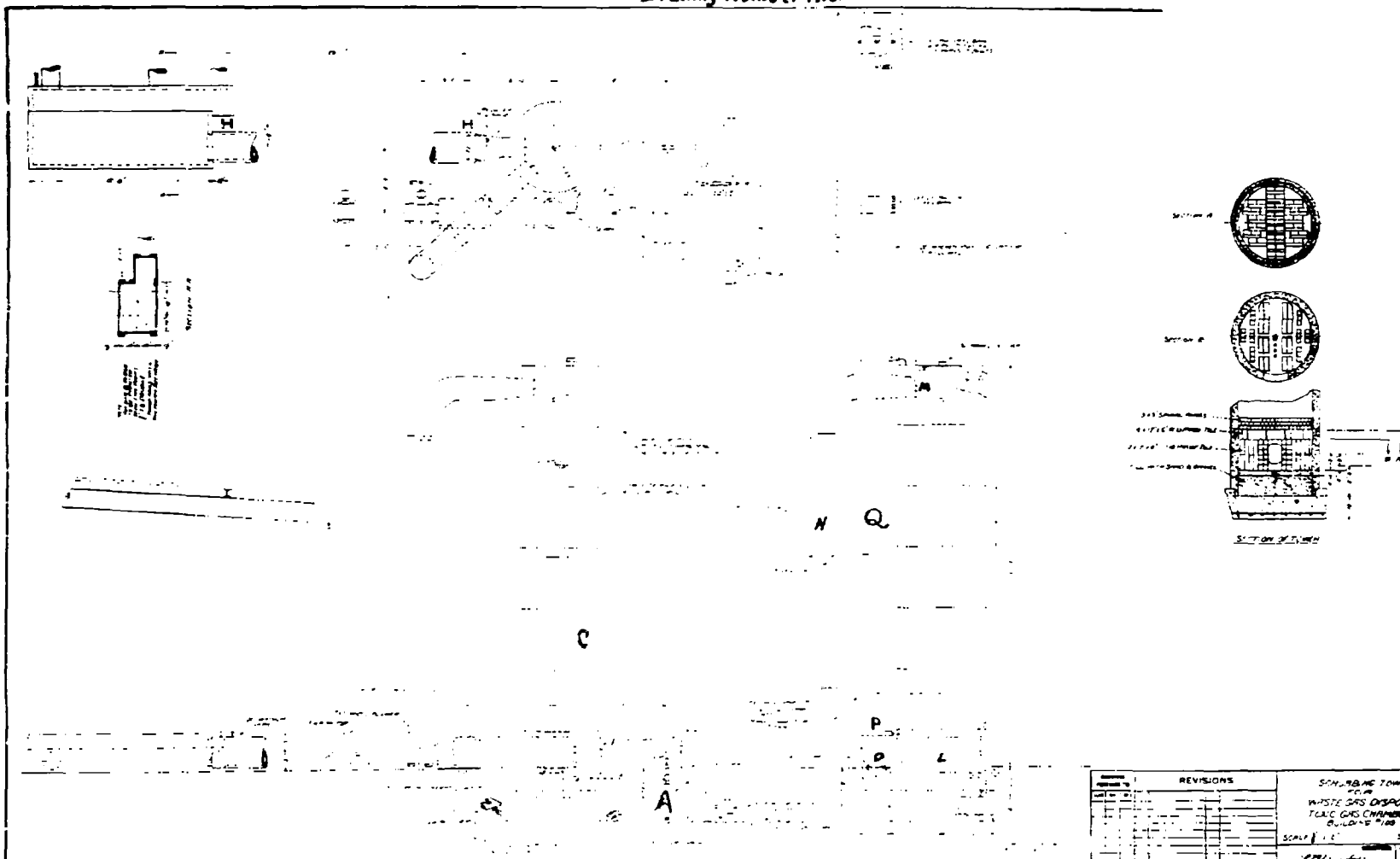
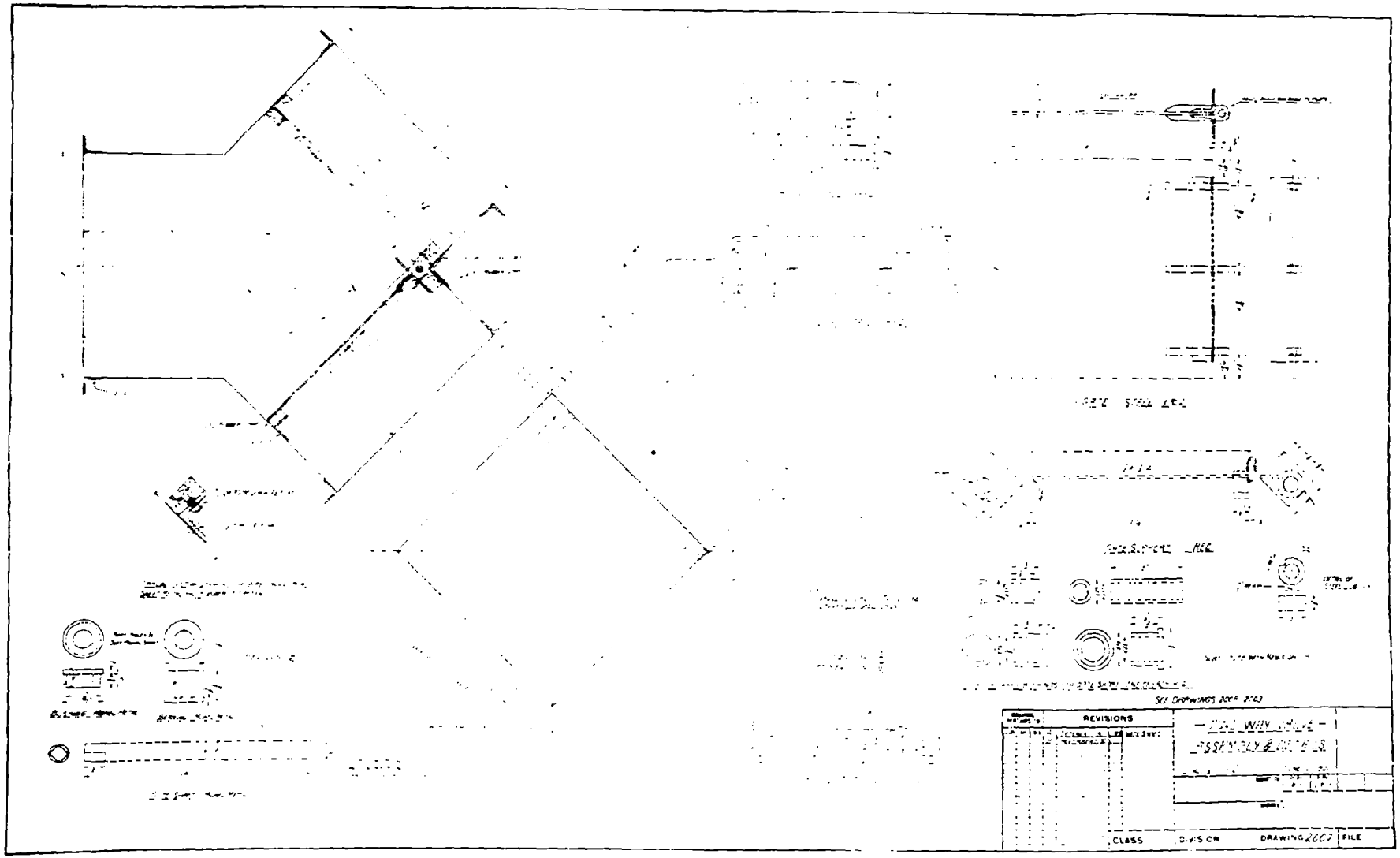


Drawing Number Three.



C. Method of Analysis:

MODIFIED VOLHARDT METHOD.

The gas-air sample was drawn off through two petticoat bubblers by means of an aspirating bottle. Five-liter samples were taken on the 5 minute, 5 minute, and 7½ minute runs. One-liter sample was taken on the 60 second run, and one-half-liter sample was taken on the 30 second run.

A 4% aqueous solution of sodium peroxide was used to absorb the gas-air sample. Fifty cubic centimeters of sodium peroxide solution were used for each sample, 25 cubic centimeters of which were used in each bubbler.

Phenolphthalein was added to the sample, then concentrated HNO_3 to acidify; ferric alum was used as the indicator. An excess of N/100 $AgNO_3$ was run in, and back titrated with N/100 KCNS. About ten cubic centimeters of ether were added to the sample to coagulate the silver chloride thus making the end point more discernible. A faint brownish color persisting for 60 seconds was taken as the end point.

D. Subjects:

A total of 137 dogs was used to determine the concentrations reported in the following pages.

E. Experimental:

1. Toxicity.

30 SECOND EXPOSURE.

The data from which the minimum lethal concentration for 30 seconds was derived are tabulated herewith:

Dog Number	Concentration	Results	
741	9.57	Recovered	
732	10.98	Died after 22 hours	1/5*
737	11.44	Recovered	Av.conc.
731	12.72	"	11.66
738	13.6	"	
760	14.33	Recovered	
1105	14.35	"	
744	14.37	Died after 14 hours	1/6
1104	14.44	Recovered	Av.conc.
1074	14.55	"	
1068	14.65	"	
736	15.94	Died after 12 hours	
1111	16.03	Recovered	3/5
1078	16.12	"	Av.conc.
751	16.35	Died after 15 hours	16.19
1118	16.52	" " 27 "	
1112	16.62	Recovered	3/4
1090	17.06	Died after 31 hours	Av.conc.
1110	17.30	" " 12 "	17.11
726	17.45	" " 14½ "	
733	18.2	Died after 15 hours	
1116	18.09	Recovered	2/5
1117	18.09	"	Av.conc.
1115	18.39	Died after 12 hours	18.29
730	18.70	Recovered	
729	19.17	Died after 15 hours	3/3
727	19.23	" " 14 "	Av.conc.
734	19.86	" " 17 "	19.51

*Numerator indicates number of deaths and denominator shows number of dogs used.

The minimal lethal concentration for 30 seconds is placed at 16.19 milligrams per liter.

60 SECOND EXPOSURE.

The data from which the minimum lethal concentration for 60 seconds was derived are tabulated below:

Dog Number	Concentration	Results	
722	4.19	Recovered	
723	5.66	"	
1137	6.42	"	0/7
728	6.77	"	Av.Conc.
724	6.96	"	6.49
749	7.33	"	
755	7.76	"	
750	7.95	Died after 36 hours	
1064	8.01	Recovered	
757	8.35	Died after 15 hours	
1071	8.36	Recovered	
1121	8.55	Died after 32 hours	5/10
1119	8.58	" " 14 "	Av.Conc.
1067	8.65	Recovered	8.41
1134	8.66	"	
725	8.75	Died after 16 hours	
1123	8.80	Recovered	
1087	8.85	Recovered	
756	8.90	"	
740	9.17	Died after 42 hours	
1115	9.54	" " 18 "	
1135	9.68	" " 12 "	*6/11
1101	9.68	" " 8 "	Av.Conc.
1124	9.73	" " 8 "	9.65
530	9.77	" " 76 "	
1108	9.78	Recovered	
1120	10.15	"	
739	10.96	Died after 15 hours	

* Dog #530 is not counted because death did not occur until after 76 hours.

The minimal lethal concentration for 60 seconds is placed at 8.41 milligrams per liter.

5 MINUTE EXPOSURE.

The data from which the minimum lethal concentration for 5 minutes was derived are tabulated below:

Dog Number	Concentration	Results	
1083	1.20	Recovered	
1092	1.21	"	
1056	1.24	Died after 60 hours	
1042	1.30	" " 9 "	4/10
1046	1.30	" " 11 "	Av.Conc.
1086	1.31	Recovered	1.30
703	1.31	"	
1057	1.36	"	
1084	1.38	Died after 24 hours	
681	1.41	Recovered	
718	1.46	Died after 18 hours	
1075	1.46	" " 24 "	
717	1.50	" " 18 "	4/7
704	1.50	" " 29 "	Av.Conc.
1106	1.51	Recovered	1.51
1080	1.56	"	
1109	1.57	"	
719	1.60	Died after 10 days	
680	1.60	" " 4 hours	
709	1.64	Recovered	6/7
708	1.65	Died after 13 hours	Av.Conc.
714	1.70	" " 85 "	1.64
679	1.71	" " 45 "	
682	1.72	" " 6 "	
715	1.75	Recovered	
706	1.78	Died after 7 hours	4/5
716	1.81	" " 13 "	Av.Conc.
675	2.02	" " 17 "	1.89
671	2.15	" " 15 "	

The minimal lethal concentration for 5 minutes is placed at 1.51 milligrams per liter.

5 MINUTE EXPOSURE.

The data from which the minimum lethal concentration for 5 minutes was derived are tabulated below:

Dog Number	Concentration	Results	
1067	0.70	Recovered	
1068	0.70	"	
767	0.81	"	0/5
768	0.81	"	Av.Conc.
1127	0.81	"	0.77
1079	0.82	Died after 32 hours	
1131	0.83	Recovered	
794	0.84	Died after 12 hours	5/7
769	0.86	Recovered	Av.Conc.
781	0.865	Died after 15 hours	0.85
795	0.87	" " 3 days	
779	0.875	" " 15 hours	
787	0.91	Recovered	
776	0.93	Died after 45 hours	
1059	0.93	" " 25 "	
1088	0.93	Recovered	4/8
1065	0.94	Died after 23 hours	Av.Conc.
785	0.95	" " 14 "	0.937
796	0.95	" " 7 days	
775	0.96	Recovered	
783	0.99	Died after 4 hours	
774	0.99	Recovered	3/4
786	1.02	Died after 3 days	Av.Conc.
1060	1.06	" " 11 hours	1.01
764	1.08	Died after 15 hours	
780	1.16	Recovered	4/5
765	1.22	Died after 15 hours	Av.Conc.
766	1.26	" " 15 "	1.21
1045	1.32	" " 3 "	

The minimal lethal concentration for 5 minutes is placed at 0.85 milligrams per liter.

7½ MINUTE EXPOSURE.

The data from which the minimum lethal concentration for 7½ minutes was derived are tabulated below:

Dog Number	Concentration	Results	
1058	0.52	Recovered	0/4
1068	0.55	"	Av.Cons.
802	0.56	Died after 5 days	0.55
1077	0.56	Recovered	
1061	0.59	Died after 6 days	
800	0.59	" " 15 hours	
1069	0.62	Recovered	4/7
801	0.62	Died after 15 hours	Av.Cons.
1044	0.64	Recovered	0.62
1049	0.64	"	
797	0.64	Died after 22 hours	
1122	0.66	Died after 13 hours	
1065	0.68	Recovered	
1107	0.68	Died after 11 hours	
798	0.69	" " 12 "	5/8
1045	0.69	" " 14 "	Av.Cons.
1125	0.70	" " 23 "	0.69
782	0.71	Recovered	
799	0.71	"	
796	0.76	Died after 12 hours	
790	0.77	" " 36 "	3/4
784	0.81	Recovered	Av.Cons.
788	0.83	Died after 36 hours	0.79

The average lethal concentration for 7½ minutes is placed at 0.62 milligrams per liter.

2. Symptomatology.

a. Symptoms during exposure:

In general, regardless of concentration or length of exposure, dogs exposed to the action of phosgene very early show evidence of the irritating effects of the gas on the exposed mucous surfaces by either a continual blinking of the eyes or a moistening of the lips. After 15 or 20 seconds lachrymation begins and if exposure lasts longer than three minutes is apt to become profuse. Salivation is usually the second symptom to appear and except at very low concentrations is as frequent a symptom as is lachrymation. Excessive nasal secretion and sneezing are less regularly noted during exposure; retching and vomiting are exceptional symptoms. A few dogs, after exposure had continued for three or four minutes, had respiratory difficulties as was shown by labored breathing; a few others were apparently oblivious to the presence of the gas. As a rule, by the end of exposure the dogs have become restless and are eager for release.

b. Symptoms following exposure:

Immediately after gassing the majority of dogs lie quietly, more or less huddled in the corners of their cages. They are depressed, but attentive to the spoken word. In some dogs after about three hours a sudden change takes place. Respiration becomes rapid, labored, audible, and with a knocking sound on expiration. Any exertion on the part of the dog greatly increases the severity of symptoms; respiration becomes increasingly difficult; fluid pours from the mouth and bubbles from the nostrils; asphyxial convulsions set in. This final period reaches its culmination in death fifteen to thirty minutes after its inception

If the dogs survive this period respiration tends to become progressively more difficult. The nostrils become filled with fluid, necessitating mouth breathing; the cheeks are puffed out on exhalation and sucked in on inspiration; a tracheal rattle is heard. The abdominal muscles may be called into play during respiration. The eyes may become inflamed, and filled with a watery discharge. Coughing may set in, and occasionally the dogs are nauseated - the vomitus consists of a clear fluid and is probably previously

swallowed edema fluid. If death occurs within twenty-four hours this condition obtains without change. The death struggles are prolonged, and the fluid which oozes from the mouth is more apt to be blood-tinged. Again the dog dies in asphyxial convulsions.

When dogs survive for three or four days the discharge in the eyes and nose frequently becomes muco-purulent in character. Coughing at times is almost incessant - at other times the dogs lie prostrate, and respiration becomes shallow and rapid. A comparatively few dogs die at this period. Of the dogs which survive the first twenty-four hours after exposure the majority recover. The process of recovery is fairly rapid, and many dogs have normal eyes and respiration after the third day.

A very few dogs at no time showed any effects of the gassing, but immediately after exposure had normal temperature, pulse and respiration rates; a few other dogs were merely depressed, and had a mild conjunctivitis which disappeared within twenty-four hours.

g. Effect on Temperature, Pulse and Respiration:

1. Temperature:

Within a few hours after gassing there is a drop to several degrees below normal temperature. This drop is soon followed by a rise to normal or above and is of variable duration. If dogs die within the first 12 hours the temperature usually drops toward normal or below shortly before death. In the dogs dying of pneumonia the initial rise usually attains a height of 4 degrees or more above normal. In the dogs which survive the temperature fluctuates around the normal after recovering from the initial drop.

2. Respiration:

The findings are very variable, but the following conditions were most frequently noted: If death occurred within 36 hours respiration was either rapid, shallow, and jerky, or was slow, deep and convulsive; if the dogs died of pneumonia, as was expected, a rapid and shallow respiration was noted; if the dogs recovered respiration was always just about normal.

b. Pulse:

The main clinical feature is the pulse rate. Very soon after gassing in all dogs there is a marked bradycardia. The rate may drop to as low as 24 per minute. This lasts for at least 6 hours, and then the pulse rate begins to increase. When death occurs within the first 12 hours after gassing the pulse rate is noted to be again decreasing and is usually below normal before death. If the dog lives until the third day the increased pulse rate is likely to persist for the first two days, but before death it drops sharply until it is below the normal limit. If the dog recovers from the exposure the decline from the initial rise is very gradual, and the pulse rate usually fluctuates around normal after the fourth day although frequently the normal rate is not attained until the sixth day.

c. Pathology:

In this report the pathological findings are divided into two groups dependent on the time of death of the animals. Group I includes dogs dying acutely within 24 hours, and Group II those dying after 24 hours from causes other than simple edema. The earliest death in Group I occurred 2 hours after exposure; the latest death in Group II occurred 25 days after exposure.

GROUP I. Forty dogs were studied as types of acute death -i.e., death within 24 hours after gassing. At autopsy these dogs are found to be in good condition. If death has occurred within the first 6 hours after gassing very little evidence of the gassing can be noted externally. Even in the dogs dying in 24 hours the external changes are at most but a mild irritation of the exposed mucous membranes. Usually the eyes are open and clear, but in some dogs the conjunctivae are injected, and evidence of a profuse lachrymation is seen by the matted condition of the hair of the face. The nasal and buccal mucosae usually are normal or only slightly inflamed. At times there is a blood stained watery fluid which runs from the mouth when the dog is handled.

In the earliest deaths - i.e., those within 2 hours, the mucosa of the larynx and trachea is normal. The lungs are voluminous, but are crepitant practically everywhere. They are light pink in color, and show over the surface emphysematous areas between which are narrow lines of atelectasis. A little froth may

well up into the trachea when the lungs are handled. Cut section reveals an edematous condition of all the lobes. Even as early as this a small amount of fluid may be present in the thoracic cavity. When death occurs after 6 hours examination reveals but a slight injection of the tracheal vessels between the cartilaginous rings, and at times an edema of the laryngeal and tracheal mucosa. In the lumen of the trachea there are quantities of froth or of frothy fluid either pure white or blood tinged. When the chest wall is removed more striking pathological changes are noted. In 10 of the 40 dogs of this group a condition of hydrothorax existed- the fluid present averaged 50 cc. and was usually a clear light cherry in color and watery in consistency. The lungs are voluminous and fill the entire cavity sometimes hiding the heart. They are mottled in color- irregularly shaped and sized whitish gray areas alternate with dull, dusky, purplish red areas. In some cases the whitish areas are puffy and stand out prominently, at other times they are flush with the surface. The white color represents areas of emphysema and such areas are more numerous on the anterior and middle lobes than on the posterior. The lungs are doughy or rubbery in consistency and easily pit on pressure. On section the surface of the lungs is red, and the walls of the bronchi, especially of the smaller ones, are swollen and stand out prominently. Fluid pours from the air cells, and blood from the cut vessels.

Microscopic examination of such lungs shows a well marked edema in nearly all the air cells. This edema is either homogeneous or filiform in character. An intense congestion and some hemorrhage are present. Areas of acute emphysema alternate with those of atelectasis. The atelectatic areas are more extensive in the regions around the bronchi. The epithelium of the smaller bronchi is usually desquamated, and the underlying structures are covered with a layer of mucus. The epithelium of the medium and large bronchi is usually intact and normal. The lumina of these latter tubes however frequently contain numerous desquamated epithelial cells and red blood corpuscles mixed with a homogeneous staining mucoid substance. Their walls are sometimes swollen, and around the smaller bronchi there is an extensive edema. A perivascular edema is also generally found. When the individual alveoli are examined it is noted that in their walls there are numerous polymorphonuclear leucocytes, and that the capillaries are patent and engorged with blood. In the more completely expanded alveoli frequently polymorphonuclear leucocytes are seen in the edematous fluid giving a picture of a

mild inflammatory condition. Fibrin was demonstrated in many of the alveolar walls, with strands crossing the capillary bed.

In a few cases as early as 24 hours definite areas of consolidation could be felt in all the lobes but especially in the posterior. On section these areas revealed a dark, firm, meaty condition of the parenchyma, swollen and inflamed bronchial walls, and pus in the lumina of the bronchi. Microscopic examination of such lungs showed well defined areas of broncho pneumonia, the foci of which were the finer bronchi.

In dogs dying acutely a well defined dilatation of the right ventricle is commonly found. The left ventricle is hard and firm. Both ventricles are filled with dark red, post-mortem blood clots. The vessels of the pericardium, both parietal and visceral, are injected. In a number of deaths around 24 hours subendocardial hemorrhages are found. The valves and muscles however, as a rule, are normal.

A general congestion exists in the abdominal cavity. In practically all dogs the liver, spleen, and particularly the kidneys are congested. No lesions were found in the stomach or intestines except when vomiting had been violent and frequent. In such cases a congestion of the duodenum was sometimes noted.

GROUP II. This group includes 17 dogs dying after the expiration of 24 hours. The earliest death was at 39 hours and the latest on the 25th day after gassing. Purulent bronchitis, broncho pneumonia or both are found in 1/3 of these dogs. Dogs dying between 39 and 72 hours showed edema, congestion, hemorrhage, atelectasis, and emphysema. After the 3rd day little or no edema is found in the lungs, but congestion, hemorrhage, atelectasis, and emphysema are again found regularly. A condition of hydrothorax was found as late as the 5th day. The dog which died on the 25th day after gassing had never apparently recovered from the effects of exposure. At autopsy emphysema and pneumonia with abscess formation were found.

In practically all these dogs hyperemia of the spleen and congestion of the liver and of the kidneys are found both macroscopically and microscopically.

4. Heart-Lung Index:

A study was made of the heart-lung index of the dogs in this series to show the amount of edema present in the lungs. The normal ratio between the weight of the empty heart and that of the lungs is given by Barcroft as 1:1.5. The following tables give the ratios found in the above series of dogs.

TABLE 1.

Dogs dying within 12 hours after exposure.

Dog #	Death in Hours	Wt. of Heart in grams	Wt. of Lungs in grams	Ratio
523	9	50	151	1:3.0
537	8	24	93	1:3.8
544	6	58	238	1:4.1
546	4	58	228	1:3.8
547	5½	58	239	1:4.1
548	11	75	405	1:5.3
554	2½	110	400	1:3.6
560	4½	142.5	811	1:5.6
565	8½	160	282	1:1.71
587	9½	90	300	1:3.24
594	10	115	325	1:3.26
682	5½	45	170	1:3.78
705	12	70	250	1:3.6
708	4	50	235	1:4.7
739	3	30	100	1:3.3
1060	12	100	241	1:2.41
1214	8	86	274	1:3.2
1216 K	5	98	328	1:3.3
1265 K	8	80	265	1:3.3
1272	9	89	326	1:3.66
1296	1½	80	256	1:3.2
			Average	1:3.41

TABLE 2.

Dogs dying between 13 and 24 hours.

Dog #	Death in Hours	Wt. of Heart in Grams	Wt. of Lungs in Grams	Ratio
717	18	60	220	1:3.66
718	20	90	365	1:4.05
725	17½	170	700	1:4.10
726	14	130	570	1:4.38
727	14	95	470	1:4.95
729	14	95	410	1:4.10
733	15	130	460	1:3.54
730	17½	160	510	1:3.08
1264	14	99	336	1:3.40
1295	14	70	264	1:3.80
1170	17	85	405	1:4.76
568	17½	63	166	1:2.64
571	22	68	206	1:3.03
569	24	59½	144	1:2.42
671	25	110	370	1:3.37
675	20	85	310	1:3.65
			Average	1:3.68

Analysis of the figures in these tables seems to indicate that in the present series of dogs the greatest amount of edema was present in the lungs of dogs dying within the first 24 hours after exposure.

Submitted by:

G. G. Armstrong

and

M. G. Witherspoon

Supervised by:

H. A. Kuhn,
1st Lt.,C.W.S.,U.S.A.
Chief, Department of Toxicology.

Approved by:

Edward B. Vedder,
Lt.Col.,M.C.,U.S.A.
Chief, Medical Research Division.

A. H. Koontz,
In charge of Pathological Section.

Authors:

G. G. Armstrong
M.G.Witherspoon

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DEPARTMENT OF THE ARMY
US ARMY RESEARCH, DEVELOPMENT AND ENGINEERING COMMAND
EDGEWOOD CHEMICAL BIOLOGICAL CENTER
5183 BLACKHAWK ROAD
ABERDEEN PROVING GROUND, MD 21010-5424

REPLY TO
ATTENTION OF

RDCB-DPC-RS

15 October 2015

MEMORANDUM THRU Director, Edgewood Chemical Biological Center, (RDCB-D/Dr. Joseph Corriveau), 5183 Blackhawk Road, Aberdeen Proving Ground, Maryland 21010-5424

FOR Defense Technical Information Center, 8725 John J. Kingman Road, Ft Belvoir, VA 22060

SUBJECT: Internal Request for Change in Distribution

1. This action is in response to an Edgewood Chemical Biological Center (ECBC) Internal Request for a Change in Distribution for the following documents as listed in attachment.

2. The listed documents have been reviewed by ECBC Subject Matter Experts and deemed suitable for the change in distribution to read "Approved for public release; distribution unlimited."

3. The point of contact is Adana Eilo, ECBC Security Specialist, (410) 436-2063 or adana.l.eilo.civ@mail.mil.

Encl

RONALD L. STAFFORD
Security Manager

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